International Conference on Inter Disciplinary Research in Engineering and Technology [ICIDRET]

ISBN	978-81-929742-5-5		**Vol**	I
Website	www.icidret.in		**eMail**	icidret@asdf.res.in
Received	14 - February - 2015		**Accepted**	25 - March - 2015
Article ID	ICIDRET024		**eAID**	ICIDRET.2015.024

Energy Conservation in Wireless Sensor Networks by Differentiated Data Delivery

S Raj Barath[1] , C KeziSelva Vijila[2]

[1]Assistant Professor, Department of ECE, Christian College of Engineering and Technology, Oddanchatram

[2]Principal, Christian College of Engineering and Technology, Oddanchatram

Abstract-*In wireless sensor networks (WSNs), packet loss occurs due to congestion. It reduces the lifetime of WSNs due to energy consumed by these transmissions. Successful event detection in Wireless Sensor Networks (WSN) requires reliability and timeliness. When an event occurs, the base station (BS) is particularly interested about reliable and timely collection of data sent by the nodes close to the event, and the data sent by other nodes have little importance. Data generated in wireless sensor networks may not all be alike: some data may be more important than others and hence may have different delivery requirements. We address differentiated data delivery in the presence of congestion in wireless sensor networks. Congestion-Aware Routing (CAR), discovers the congested zone of the network that exists between high-priority data sources and the data sink and, using simple forwarding rules, dedicates this portion of the network to forwarding primarily high-priority traffic.Fair Share rate is calculated in Fairness aware congestion control to improve the energy conservation in WSN. The Fair share rate is allotted to all nodes in the network to achieve reliability and timeliness.*

Keywords: Congestion control, Wireless Sensor Networks, Congestion Aware Routing(CAR), High Priority (HP) , Low Priority (LP).

I INTRODUCTION

WIRELESS SENSOR NETWORKS (WSNs) consists of a large number of sensor nodes. WSNs are undoubtedly one of the largest growing types of networks today. They are fast becoming one of the largest growing types of networks today and, as such, have attracted quite a bit of research interest. They are used in many aspects of our lives including environmental analysis and monitoring, battlefield surveillance and management, emergency response, medical monitoring and inventory management. Their reliability, cost effectiveness, ease of deployment and ability to operate in an unattended environment, among other positive characteristics, make sensor networks the leading choice of networks for these applications [3].

A wireless network normally consists of a large number of distributed nodes that organize themselves in an ad-hoc fashion. Each node has one or more sensors embedded processors and low power radios which are normally battery operated. Unlike other wireless networks, it is generally difficult or impractical to charge/replace exhausted batteries. The primary objective in wireless sensor networks design is maximizing node/network lifetime, leaving the other performance metrics as secondary objectives. Various factors like concurrent transmissions, buffer overflows and dynamically time varying wireless channel condition lead to the concept of Congestion.

It causes many folds of drawbacks:

(A) Increase energy dissipation rates of sensor nodes,
(B) Causes a lot of packet loss, which in turn diminish the network throughput
(C) Hinders fair event detections and reliable data transmissions.

This paper is prepared exclusively for International Conference on Inter Disciplinary Research in Engineering and Technology [ICIDRET] which is published by ASDF International, Registered in London, United Kingdom. Permission to make digital or hard copies of part or all of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage, and that copies bear this notice and the full citation on the first page. Copyrights for third-party components of this work must be honoured. For all other uses, contact the owner/author(s). Copyright Holder can be reached at copy@asdf.international for distribution.

2015 © Reserved by ASDF.international

Cite this article as: S Raj Barath, C Kezi Selva Vijila. “Energy Conservation in Wireless Sensor Networks by Differentiated Data Delivery.” *International Conference on Inter Disciplinary Research in Engineering and Technology* (2015): 158-162. Print.

II RELATED WORKS

The event driven nature of wireless sensor network which leads to congestion in the network. To deal with congestion in wireless sensor networks, many congestion mitigation, congestion control and reliable transmission have been proposed these mechanism have been have been categorized into three groups such as:

- End to end reliability without congestion control (RMTS).
- Centralized congestion control scheme (ESRT).
- Distributed congestion control scheme (FUSION).

A. RMST: Reliable multi segment transport.

The reliable multi segment transport (RMST) provides end to end reliability without any congestion control. Using these mechanism packet loss which occur during transmission of packets from source node to sink node are recovered hop by hop using cache which are present in the intermediate node[16].

In RMTS packets which are lost are detected using a timer both in cached and un-cached mode, a "watchdog timer" is initiated for each and every node along the path from source to destination/sink. The watchdog timer detects gaps within the cache and send a negative acknowledge (NACK) to its neighboring node along the path towards source, the intermediate node which detect these negative acknowledge (NACK) identifies the request for lost packet and retransmits the packet to the requested node.

B. ESRT: Event to sink reliable transport protocol.

In event to sink reliable transport protocol the rate at which each sensor node transmits is centrally computed, the base or sink node which calculates the transmission rate based on the number of sensor readings received by which the ESRT provides end to end reliability in wireless sensor networks [17].

There are two events related to ESRT

The observed event reliability (r):-the observed event reliability indicates the number of data packets received in decision interval and it is indicated using (r).

The desired event reliability (R):-the desired event reliability indicates the number of data packets required detecting a particular event and it is indicated using (R).

If $r>R$ then a particular event is detected.

Else-if $r<R$ then appropriate actions are taken to detect the event.

In Event to sink reliable transport protocol the network can either be a low reliable state or high reliable state. Depending on the current state si and the initial reporting frequency, the ESRT calculates the update reporting frequency which is broadcasted to the source node in order to detect the possible event.

C. Fusion.

The Fusion is a distributed congestion control scheme which is based on queue length to measure the level of congestion. Fusion is a combination of three congestion control techniques namely

- Hop by hop flow control.
- Source rate limiting scheme.
- Prioritized MAC layer.

The hop by hop flow control consists of two parts congestion detection and congestion mitigation. In congestion detection can be performed using two methods queue occupancy and channel sampling.The rate limiting scheme is a more general approach that better handles variable rates would nodes required to propagate. Each sensor node listens to the traffic its parent forward the total no of source routing through the parent, then use a token bucket scheme to regulate each sensor nodes sending rate A sensor accumulates one token every time it hears its parent forward N packets, up to a maximum number of tokens.

III METHODOLOGY USED

A. Design of Congestion-Aware Routing (CAR)

CAR is a network-layer solution to provide differentiated service in congested sensor networks. CAR also prevents severe degradation of service to Low Priority(LP) data by utilizing uncongested parts of the network. An important event occurs in one portion of the sensor field, which we call the critical area. There is a data processing centre for collecting sensitive information from the critical area.

The area that contains the shortest paths from the critical area to the sink as the conzone.

The CAR protocol design has two phases
(1)Design of conzone and
(2)Routing packets inside and outside the conzone.

Cite this article as: S Raj Barath, C Kezi Selva Vijila. "Energy Conservation in Wireless Sensor Networks by Differentiated Data Delivery." *International Conference on Inter Disciplinary Research in Engineering and Technology* (2015): 158-162. Print.

CAR provides differentiated routing based on priority of the nodes. The combination of these functions segments the network into on-conzone and off-conzone nodes. Only High Priority(HP) traffic is routed by on-conzone nodes. Note that the protocol specifically accommodates LP traffic, albeit with less efficient routes than HP traffic. For the purposes of this discussion, we assume that there is one HP sink and a contiguous part of the network (critical area) that generates HP data in the presence of network wide background LP traffic.

Therefore, even when the rate of HP data is relatively low, the background noise created by LP traffic will create a conzone that spans the network from the critical area to the sink. Due to this congestion, service provided to HP data may degrade, and nodes within this area may die sooner than others, leading to only suboptimal paths being available for HP data, or a network partition may result, isolating the sink from the critical area.

B. FAIRNESS AWARE CONGESTION CONTROL – (FACC)

To avoid transmissions of unnecessary packets that will otherwise cause a waste of bandwidth and energy, the sending rate of each flow should be adjusted to an appropriate level as early as possible. It is desirable to adjust the sending rate of each flow at the nodes that are close to source nodes[3]. On the other hand, in WSNs, the nodes that are close to the sink forward more traffic than other intermediate nodes. Thus, their resource and energy are more precious. To adjust the sending rate of each flow as early as possible and save the scarce resource at the nodes close to the sink at the same time, we categorize all intermediate sensor nodes into near-source nodes and near-sink

We introduce two concepts, i.e., near-source nodes and near-sink nodes. Just as their names imply, near-source nodes are those nodes close to source nodes, and near-sink nodes are those nodes close to the sink. We use the optional field as our specific label field for the purpose of differentiation. Every source node sets its label field (e.g., label = k) for every packet. This label indicates how far away this packet is from the sensing field. Every forwarding node updates the label field by subtracting one (label = label −1) when it receives a packet until the label field equals zero. During a fixed interval, every intermediate node calculates the ratio Rp as

$$\mathrm{Rp} = \frac{\#\text{ of packets (label} > 0)}{\#\text{ of total passing packets}}$$

Intuitively, the larger Rp is, the closer the node is to the source nodes. Therefore, the intermediate node is a near-source node if Rp is no less than a threshold Tp (e.g., 90%). Otherwise, the intermediate node is a near-sink node. In WSNs, a flow usually traverses a few hops from its source to the sink. The number of hops can be determined by routing protocols and may be dynamic. The intermediate nodes in the path will cooperate with each other to transmit the packet to the sink.

Steps Involved in the Near Source Node Process:

- Estimation of the Available Bandwidth
- Computation of the Flow Arrival Rate
- Estimation of the Number of Active Flows
- Fair-Resource Allocation

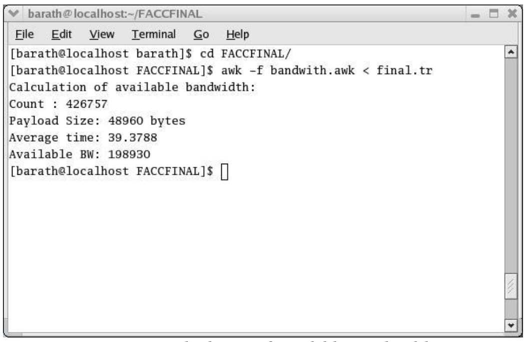

Figure 1. Calculation of Available Bandwidth

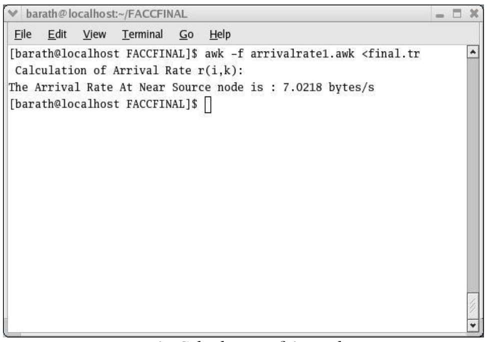

Figure 2. Calculation of Arrival Rate

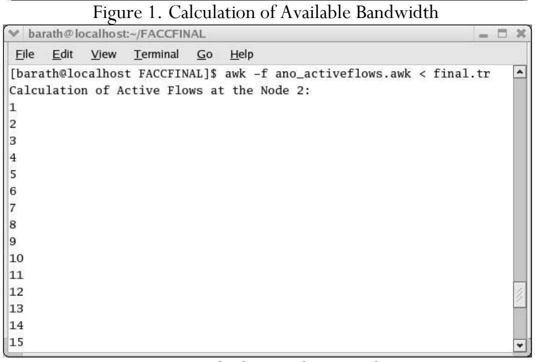

Figure 3. Calculation of Active Flows

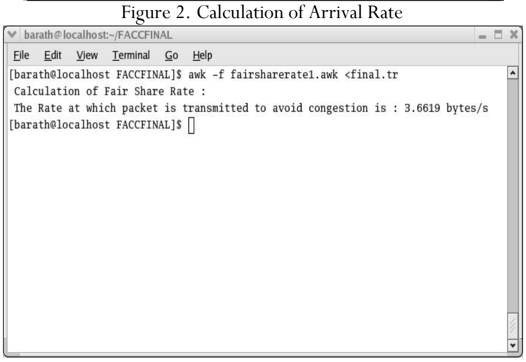

Figure 4. Calculation of Fair Share Rate

Cite this article as: S Raj Barath, C Kezi Selva Vijila. "Energy Conservation in Wireless Sensor Networks by Differentiated Data Delivery." *International Conference on Inter Disciplinary Research in Engineering and Technology* (2015): 158-162. Print.

The available bandwidth of each node, which is denoted by BWa, can be estimated as

$$BWa = \begin{cases} 0, & cb \geq thb \\ \frac{BW(thb-cb)data}{Ts}, & cb < thb \end{cases}$$

Where BW is the transmission rate in bits per second for the DATA packet, and Ts is the average time of a successful transmission at the MAC layer.cb is the channel busy ratio, thb is the threshold value fixed at the optimized rate. At each nearsource sensor node, we use exponential averaging, to estimate the rate of a flow. Let T(i,k) be the arrival time of the kth packet of flow i and l be the packet length. The estimated rate of flow i, i.e., R(i,k), is updated when the kth packet is received as

$$R(i,k)=1-[\, e\text{^-}(T(i,k)/K)l/T(i,k) \,] + [\, e\text{^-}(T(i,k)/K)*(R(i,k-1) \,]$$

Where (T(i,k) = tki − tk−1) i is the interpacket arrival time, and K is a constant.. For WSNs, all sensors generate or relay packets. Flows terminate only at the sink. Since the channel is shared by both incoming and outgoing traffic, the number of flows J should be different from the real number of flows. Thus, J can be estimated as

$$J = \begin{cases} 2N+1, & \text{If a flow is originated} \\ 2N, & \text{If not} \end{cases}$$

The fair share rate allocation F(t) is computed as F(t)= (thb/cb) × (S/J) and it is allocated to all the sensor nodes in the network. Since both the incoming and outgoing traffic of each node consume the same shared channel resource, S should include the total traffic load (in bytes). A fair share of available bandwidth is provided to the sensor node according to its generating rate, which in turn is used for congestion control in Wireless Sensor Networks.

IV COMPARISON OF PARAMETERS

A. Throughput:

In communication networks, throughput or network throughput is the average rate of successful message delivery over a communication channel. The throughput is usually measured in bits per second (bit/s or bps), and sometimes in data packets per second or data packets per time slot.

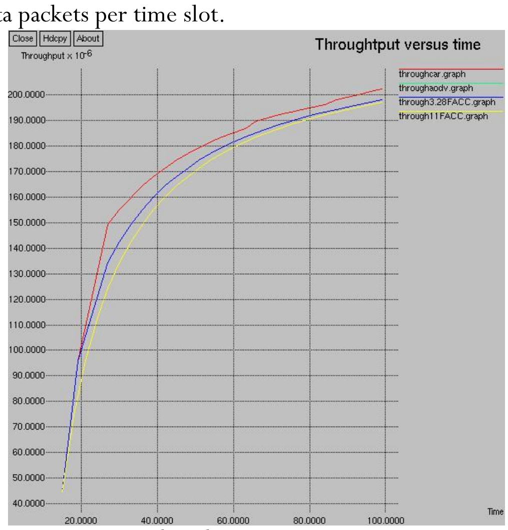

Figure 5. Throughput Comparison

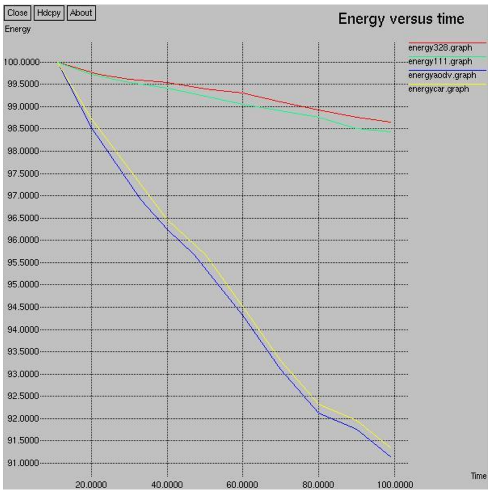

Figure 6. Energy Conservation Comparison

The Throughput of CAR is always high when compared to that other schemes as seen in figure 5. The FACC also has a better throughput when the Fair share rate is allocated.CAR provides a much better throughput because HP Packets are routed through the conzonewhereas LP packets are routed away from the conzone.

B.Energy Conservation:

The Energy plot shown in figure 6 clearly reveals that that the enhancement technique FACC provides more energy conservation. In Wireless Sensor Networks Energy Conservation is the main constraint. Though the Throughput and other factors are better in CAR ,the Energy conservation is poor compared to FACC.

TABLE I
ENERGY CONSERVATION IN VARIOUS METHODS

Method Involved	Energy Conservation
AODV	91.14%
CAR	91.37%
FACC at Normal Rate	98.22%
FACC at Fair Share Rate	98.64%

With the use of FACC in CAR, the Energy can be conserved. Table I Lists out the percentage of energy conservation in various methods.With the allocation of Fair Share Rate it can be seen that the energy conservation is higher when compared to the previous techniques.

Cite this article as: S Raj Barath, C Kezi Selva Vijila. "Energy Conservation in Wireless Sensor Networks by Differentiated Data Delivery." *International Conference on Inter Disciplinary Research in Engineering and Technology* (2015): 158-162. Print.

V CONCLUSION

Data delivery issues are addressed in the presence of congestion in wireless sensor networks. CAR increases the fraction of HP data delivery and decreases delay and jitter for such delivery while using energy more uniformly in the deployment. CAR and its variants appear suitable to real-time data delivery. This can be further improved if we bring in conzone discovery process and cost efficient routing.

To achieve an approximately fair bandwidth share, fairness-aware congestion control (FACC) can be used. It allocates an efficient rate based on available bandwidth and data rate generated by each node. FACC is much efficient as a fair rate is calculated and allocated. It minimizes the packet drop and increases the throughput of the network. Thus FACC efficiently utilizes the available bandwidth by allocating it to the nodes which is based on their data generation rate.

REFERENCES

[1] Mohammad MasumuzzamanBhuiyan, IqbalGondal and JoarderKamruzzaman, "CAM - Congestion Avoidance and Mitigation in Wireless Sensor Networks", IEEE Vehicular Technology Conference (VTC 2010 – Spring) May 2010.

[2]LiqiangTao ,Fengqiyuecoda, "Enhanced Congestion Detection and Avoidance for Multiple Class of Traffic in Sensor Networks", 15th IEEE Asia Pacific Conference on Communications – APCC Oct 2009

[3]Xiaoyan Yin, Xingshe Zhou, Rongsheng Huang, "A Fairness-Aware Congestion Control Scheme in Wireless Sensor Networks", IEEE Transactions on Vehicular Technology Nov 2009.

[4]Jang-Ping Sheu, Wei-Kai Hu, "Hybrid Congestion Control Protocol in Wireless Sensor Networks", IEEE Vehicular Technology Conference(VTC 2008 – Spring)

[5]Zhibin Li, Peter X. Liu, "Priority-based Congestion Control in Multi-path and Multi-hop Wireless Sensor Networks", IEEE International Conference on Robotics and Biomimetrics, ROBIO 2007

[6] C.T. Ee and R. Bajcsy, "Congestion Control and Fairness for Many-to-One Routing in Sensor Networks," Proc. Second ACM Conf. Embedded Networked Sensor Systems (SenSys '04), pp. 148-161, 2004.

[7] E. Felemban, C.-G. Lee, and E. Ekici, "MMSPEED: Multipath Multi-SPEED Protocol for QoS Guarantee of Reliability and Timeliness in Wireless Sensor Networks," IEEE Trans. Mobile Computing, vol. 6, pp. 738-754, 2006.

[8] T. He, J.A. Stankovic, C. Lu, and T. Abdelzaher, "Speed: A Stateless Protocol for Real-Time Communication in Sensor Networks," Proc. 23rd IEEE Int'l Conf. Distributed Computing Systems (ICDCS), 2003.

[9] J. Hill, R. Szewczyk, A. Woo, S. Hollar, D. Culler, and K. Pister, "System Architecture Directions for Network Sensors," Proc. Ninth Int'l Conf. Architectural Support for Programming Languages and Operating Systems (ASPLOS '00), Nov. 2000.

[10]B. Hull, K. Jamieson, and H. Balakrishnan, "Mitigating Congestion in Wireless Sensor Networks," Proc. Second ACM Conf. Embedded Networked Sensor Systems (SenSys), 2004.

[11] S. Madden, M. Franklin, J. Hellerstein, and W. Hong, "Tag: A Tiny Aggregation Service for Ad-Hoc Sensor Networks," Proc. Fifth Symp. Operating System Design and Implementation (OSDI), 2002.

[12]D.B. Johnson and D.A. Maltz, "Dynamic Source Routing in Ad Hoc Wireless Networks," Mobile Computing, pp. 153-181, Kluwer Academic Publishers, Feb. 1996.

[13] B. Karp and H. Kung, "GPSR: Greedy Perimeter Stateless Routing for Wireless Networks," Proc. ACM MobiCom, 2000.

[14] C. Lu, B. Blum, T. Abdelzaher, J. Stankovic, and T. He, "RAP: A Real-Time Communication Architecture for Large-Scale Wireless Sensor Networks," Proc. Eighth IEEE Real-Time and Embedded Technology and Applications Symp. (RTAS '02), pp. 55-66, 2002.

[15] I. Akyildiz, W.Su, Y. Sankarasubramaniam, and E. Cayirci, "A survey on sensor networks," IEEE Commun. Mag., vol. 40, no. 8, pp. 102–104, Aug. 2002.

[16]. F. Stann and J. Herdemann, "RMST: Reliable data transport in sensor networks," in Pro. 1st IEEE Workshop SNPA, Anchorage, AK, Nov. 2003, pp. 102–112.

[17] Y. Sankarasubramaniam, O. Akan, and I. F. Akyildiz, "ESRT: Event-to-sink reliable transport in wireless sensor networks," in Proc. 4th ACM Int. Symp. Mobile ad hoc Network.Comput.MobiHoc, Annapolis, MD, Jun. 2003, pp. 177–188.

Cite this article as: S Raj Barath, C Kezi Selva Vijila. "Energy Conservation in Wireless Sensor Networks by Differentiated Data Delivery." *International Conference on Inter Disciplinary Research in Engineering and Technology* (2015): 158-162. Print.